(12) # UK Patent Application (19) GB (11) 2 154 388 A

(43) Application published 4 Sep 1985

(21) Application No 8403814

(22) Date of filing 14 Feb 1984

(71) Applicant
The Secretary of State for Defence (United Kingdom), Whitehall, London S W 1A 2HB

(72) Inventor
Douglas Edward Burgess

(74) Agent and/or Address for Service
J B Edwards,
Procurement Executive, Ministry of Defence, Patents 1A4, Room 2014, Empress State Building, Lillie Road, London S W 6 1TR

(51) INT CL[4]
H04N 5/76 3/15

(52) Domestic classification
H4F D12M D12X D18R D18X D22 D24 D30K D53D D57 D59X D83B DC
H4D 244 264 353 356 365 368
U1S 1819 H4F

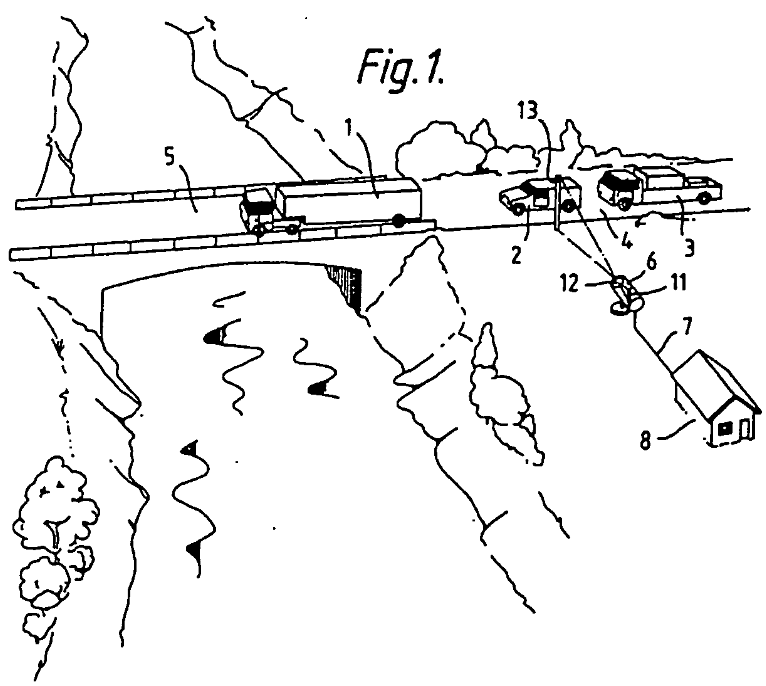
(56) Documents cited
None

(58) Field of search
H4F
G1G
H4D

(54) ## Image processing system

(57) An imaging system is used to monitor numbers and type of vehicles 1, 2, 3 approaching e.g. bridge 5 subject to weight restrictions. The system uses a fixed vertical array 11 of sensors to produce an image of vehicles passing the array. Photo, infra red, or radar sensors may be used. The sensors 11 are sampled e.g. at 50 times per second and the resultant information stored in a read/write memory array (25). About e.g. 40 seconds of sampling is held in store. Once full the memory (25) is overwritten with new information. Part of the memory at a time is read out onto a television monitor screen (48). By varying the read address positions (31, 33) for each television field an observed vehicle 2 is given a movement across the television screen (48). Also the read address positions (31, 33) can be varied to give a pan effect so the vehicle can be held stationary or moved quickly backwards or forwards across the screen.

Fig.1.



GB 2 154 388 A

The drawing(s) originally filed was/were informal and the print here reproduced is taken from a later filed formal copy.

Fig. 1.

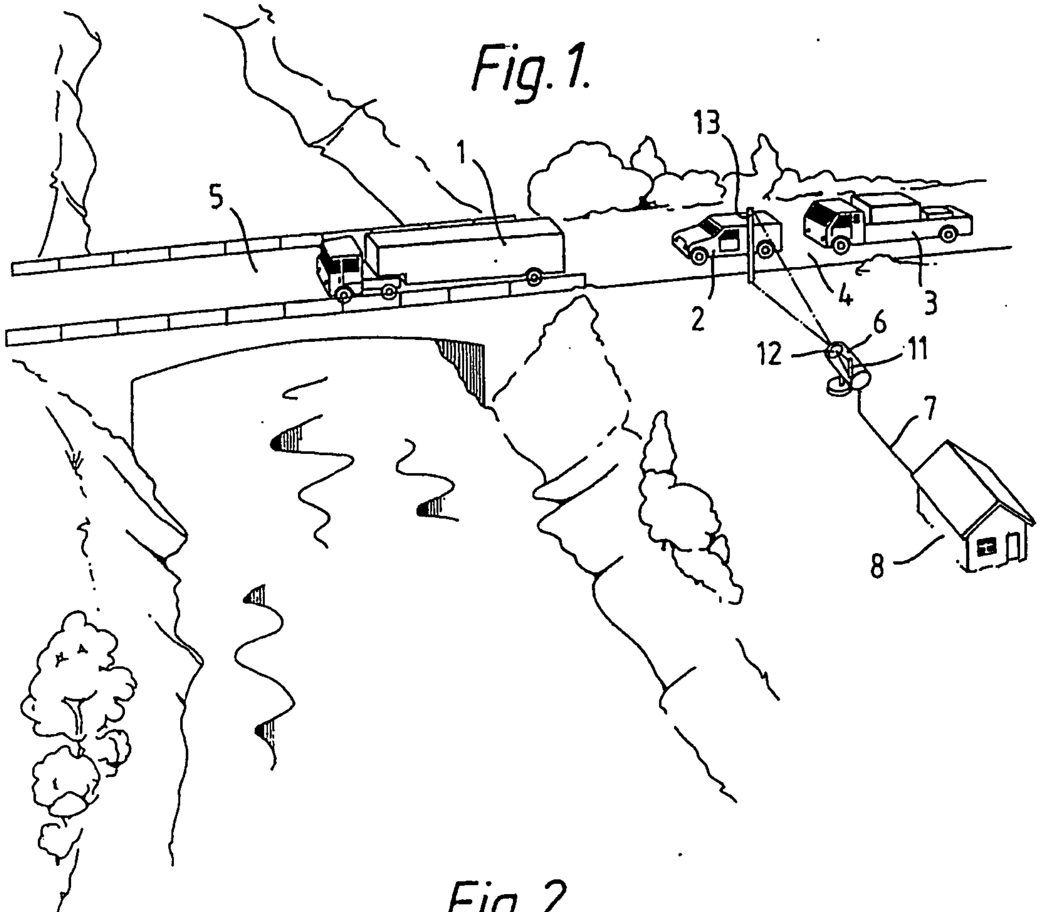

1
2
3
4
5
6
7
8
11
12
13

Fig. 2.

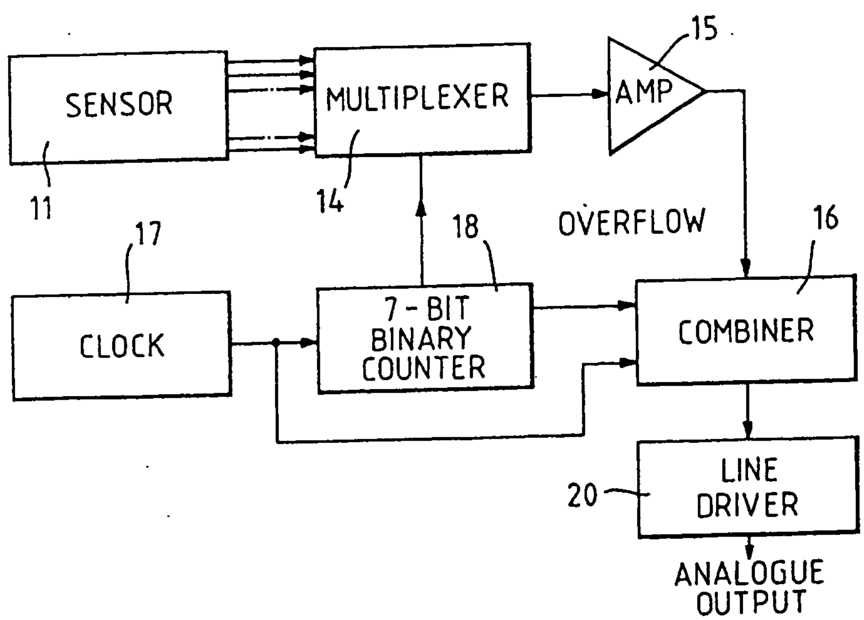

SENSOR
11
MULTIPLEXER
14
AMP
15
OVERFLOW
16
17
18
CLOCK
7-BIT BINARY COUNTER
COMBINER
20
LINE DRIVER
ANALOGUE OUTPUT

Fig. 3.

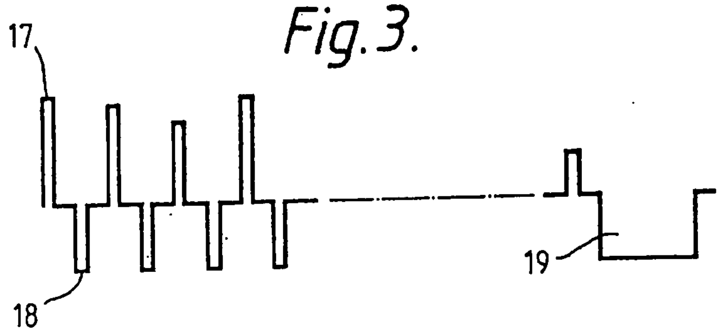


Fig. 6.

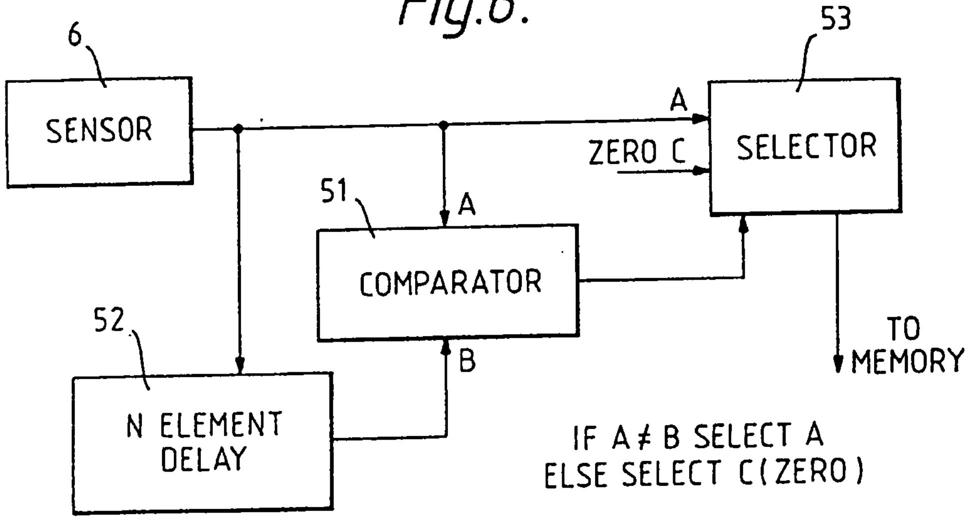


Fig. 7.

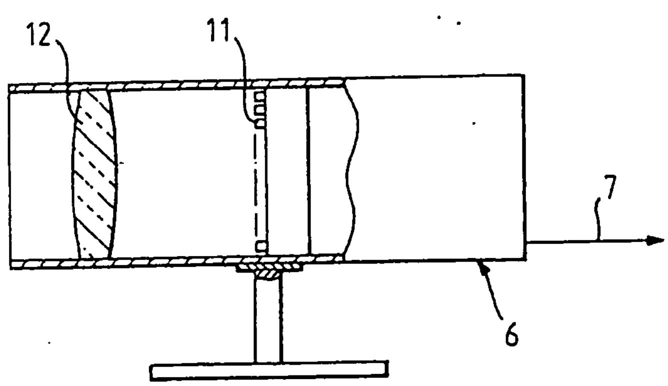


Fig. 4.

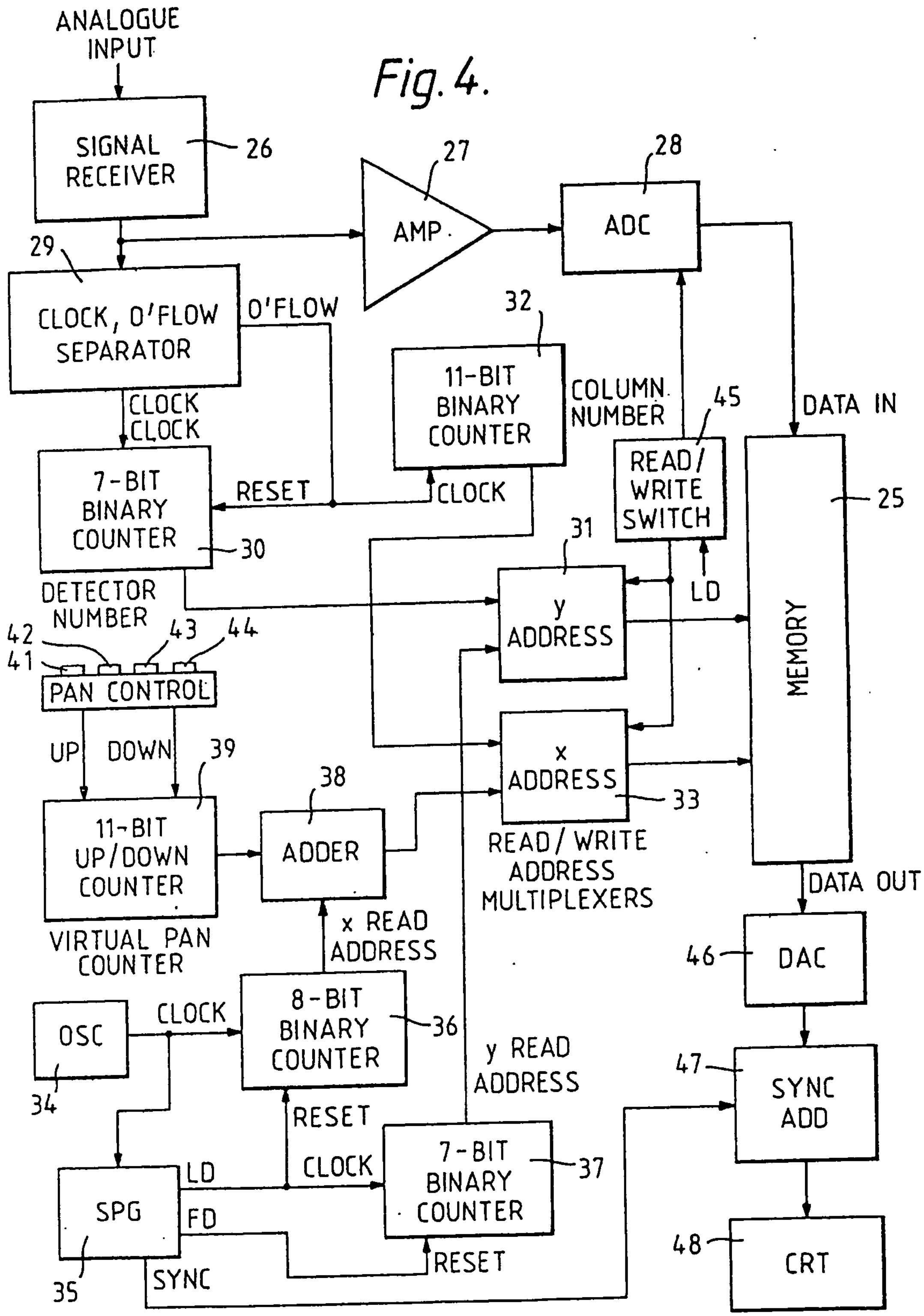
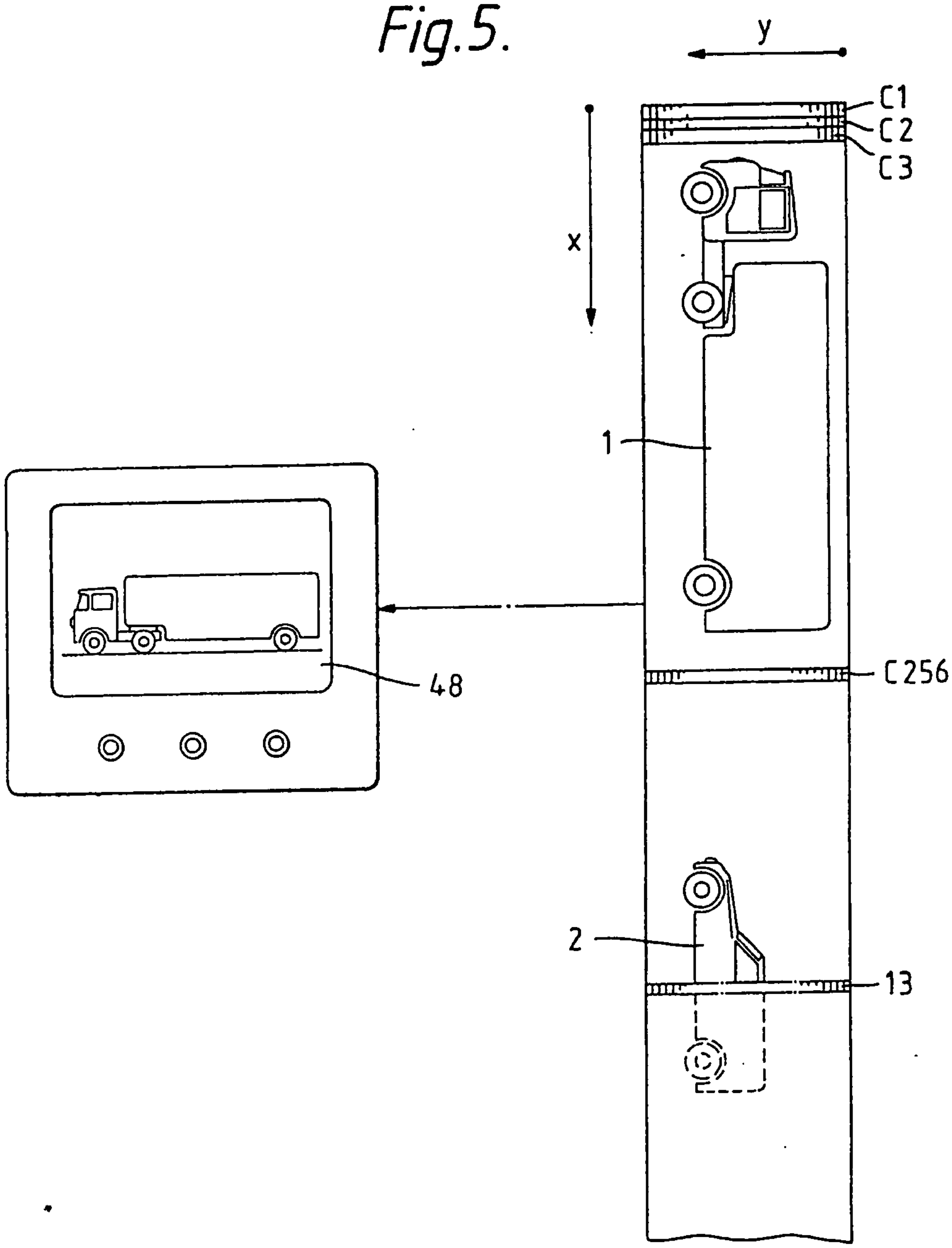

ANALOGUE INPUT
SIGNAL RECEIVER
26
27
AMP
28
ADC
29
CLOCK, O'FLOW SEPARATOR
O'FLOW
32
11-BIT BINARY COUNTER
COLUMN NUMBER
45
DATA IN
CLOCK
CLOCK
7-BIT BINARY COUNTER
RESET
CLOCK
READ/ WRITE SWITCH
25
30
31
DETECTOR NUMBER
y ADDRESS
LD
MEMORY
42
43
44
41
PAN CONTROL
UP
DOWN
39
x ADDRESS
38
33
11-BIT UP/DOWN COUNTER
ADDER
READ/ WRITE ADDRESS MULTIPLEXERS
DATA OUT
VIRTUAL PAN COUNTER
x READ ADDRESS
46
DAC
OSC
CLOCK
8-BIT BINARY COUNTER
36
y READ ADDRESS
47
SYNC ADD
34
RESET
SPG
LD
CLOCK
7-BIT BINARY COUNTER
37
FD
48
CRT
35
SYNC
RESET

Fig.5.



SPECIFICATION

Image processing system

The invention relates to an image, processing system in which a linear array of detectors is swept over a scene to provide a two dimensional display.

Examples of these systems are in thermal imaging where a parallel array of detectors are scanned across a scene by rotating prisms. Usually these detectors are also given a vertical scan, and the resultant display is formed of a plurality of banded scans. One use of imaging systems is in traffic monitoring. For exampled checking on the number and type of vehicles passing onto a bridge subject to weight restrictions. Television systems using video cameras and television (TV) monitors can be used. However such systems require relatively heavy co-axial cable and utilise a large bandwidth. When monitoring at a large number of points is needed the cost becomes large.

Cost and complexity can be reduced in accordance with this invention by using a stationary vertical linear array of sensors and allowing a vehicle's movement to effect a scanning.

According to this invention an imaging system comprises a row of sensor elements which in operation is arranged substantially vertically, means for sequentially sampling the sensor element outputs, means for transmitting and receiving the sensor elements outputs, a memory array capable of storing signals representing successive samples of sensor element output, means for writing the sensor outputs into the memory, means for cyclically reading out a section of the memory, a display unit for observing the memory output, means for varying the section of memory read cyclically into the display, whereby vehicles moving past the sensors may be observed to move across the display at a speed dependent on the vehicle's speed or at a speed and direction controlled by an operator.

The sensors may be photo detectors operating with visible light.

Alternatively the sensors may be infra red detectors such as pyro electric detectors. Such pyro electric detectors may be used in conjunction with a rotary light chopper. An infra red, 10.6 μm wavelength, illuminating laser may be used to enhance detection.

Alternatively the sensors may be small wavelength radar detectors used in conjunction with an illuminating aerial.

Movement of vehicles may be observed in real-time or recorded for subsequent inspection. Also the receiving and display sections may be switched off, to reduce power consumption, when no vehicle is passing the sensor.

The invention will now be described, by way of example only with reference to the accompanying drawings of which:

Figure 1 is a diagrammatic view of the imaging system monitoring traffic passing onto a bridge;

Figure 2 is a block diagram of a sensor head;

Figure 3 is a waveform diagram for Figure 2;

Figure 4 is a block diagram of a receiver and display unit;

Figure 5 is a pictorial view of part of Figure 4;

Figure 6 is a block diagram for a movement detection

Figure 7 is an enlarged view of the sensor head shown in Figure 1.

As shown in Figure 1 traffic 1, 2, 3, along a road 4 leading to a bridge 5 is to be monitored. This is necessary for example on long suspension bridges subject to weight restrictions. It is necessary to determine the number and type of vehicles 1,2,3. A sensor head 6 is positioned to view across the road 4 and transmits data along a twisted pair cable 7 back to a monitoring building 8 equiped with a receiver 9 and display unit 10.

The sensor head 6 has a vertical row of 128 separate photodetectors 11 focussed by a lens 12 to a vertical strip 13 across the road 4. As vehicles 1, 2, 3 move across this vertical strip they effect a scanning by the sensor head 6. The sensor head 6 comprises the lens 12, the 128 element array 11, and the electronics shown in Figure 2 all in a watertight container (not shown). The array 11 may be a charge coupled device (C.C.D.) unit e.g. Fairchild CCD III. A 12 volt rechargeable battery (not shown) provides power.

As seen in Figure 2 the 128 element sensor 11 sends its outputs through a 1:128 multiplexer 14 and amplifier 15 to a combiner 16.

A clock 17 gives a pulsed output at 6400 Hz into a binary counter 18 and the combiner 16. The binary counter 18 sequentially outputs the number 0 to 127 to control the multiplexer 14 and allowing sequential reading of each element. An overflow output is made to the combiner 16. All 128 elements 11 are sampled 50 times per second. The combiner 16 output is shown in Figure 3 where the D.C. levels 17 of each sensor element 11 are shown as positive values interposed between negative clock pulses 18 with a timing pulse 19 after the 127th element is read. This timing pulse 19 comes from the overflow output of the counter 18. The combiner 16 output is sent through a line driver 20 and along the twisted pair cable 7 to the receiver unit 9, 10 shown in Figure 4.

The receiver unit comprises a read and write memory 25 having 128 x 2048 memory positions. These allow the storage of 2048 sequential readings of the 128 sensor

elements 11. At a sensor sample rate of 50 Hz the memory 25 stores about 40 seconds of information. The upper part of Figure 4 forms the write section of the unit whilst the lower part forms the read section of the unit.

The analogue output from the sensor 11 is received by a signal receiver 26. This separates the (positive) sensor element signals 17 into an amplifier 27 and analogue to digital converter (A.D.C.) 28. A buffer store is contained within the analogue to digital converter 28. The signal receiver 26 sends the clocking pulses 18 and overflow 19 pulse part of the input signal into a separator 29 for reconstitution of clocking pulses (c.p.) and an overflow or timing pulse. The pulses c.p. clock a 7-bit counter 30 whose output is fed to a y-read/write address multiplexer 31.

This causes the memory positions corresponding to sensor element 1 to 128 to be addressed. The counter 30 is reset by an overflow pulse from the separator 29. The overflow pulse is also used to clock an 11-bit counter 32 whose output is fed to an x-read/write address multiplexer 33. This causes the memory positions corresponding to 2048 successive sensor head outputs to be addressed.

The read part of the receiver unit comprises an oscillator 34 running at 5 MHz. Oscillator 34 pulses clock a synchronisation pulse generator (S.P.G.) 35 and an 8-bit counter 36. This synchronisation pulse generator 35 provides television compatible outputs at a line drive (L.D.) frequency of 15.6 KHz, a field drive (F.D.) frequency of 50 Hz, and a synchronisation signal (sync). Line drive pulses reset the 8-bit counter 36, and clock a 7-bit counter 37 reset by the field drive signal. Output 0 to 127 from the 7-bit counter 37 form the address instructions to the y-address multiplexer 31. Outputs 0 to 255 from the 8-bit counter 36 are directed through an adder 38 to the x-address multiplexer 33. The adder 38 also receives an input from an 11-bit counter 39. This counter 39 together with operator controlled switches 40, 41, 42, 43 form a virtual pan unit giving fast and slow back and forwards pan of an observed display, as described later. The normal conditions of the switches 41, 42, 43, 44 is to connect the separator 29 overflow signal to increment the counter 39; this represents a slow forwards pass.

Operation of a freeze switch 42 disconnects the overflow signal to the counter 39. Operator actuation of fast backward and fast forward switches 44, 41 increases and decreases the counter 39 output. Typically the fast pan signals are at 200 Hz. A slow backwards scan switch 43 applies pulses at 50 Hz to decrease the counters 39 output count.

A read/write (R/W) switch 45 clocked by the line drive signal controls the read and write multiplexers 31, 33, and the analogue to digital converter 28 loading into the memory 25.

Output from the memory 25 is through a digital to analogue converter (D.A.C.) 46 and a synchronisation add circuit 47 to cathode ray tube 48 e.g. a Television monitor,

Operation to observe vehicles will now be described. Figure 5 shows schematically the contents 1, 2 of the memory and the cathode ray tube 48 display after a period of time.

The output of each sensor element 11 is read sequentially and sent to the combiner 16 as the counter 18 output cycles through the numbers 0 to 127.

Output from the line driver 20 is thus a series of signals each representing a vertical column (Ci) of information spaced 1/50 sec apart in time, i = 1 to 2048.

The signal receiver 26 passes the sensor 11 outputs to the analogue to digital converter 28 which outputs 128 discrete digit numbers for each column (C). With the read/write switch 45 set in the write condition output from the analogue to digital converter 28 passes into the memory 25 at the y-positions controlled by the y-address multiplexer 31 clocked by the counter 30 at the clock 29 frequency. The information is entered at the x position set by the x-address number. As a result each column Ci of information is entered in the memory in 128 adjacent memory positions y = 1 to 128. The counter 30 resets to zero as the overflow pulse indexes the counter 32 and the x-address multiplexer 32. A new column ci of information is then entered into the memory 25 at a different x position. Successive columns Ci are thus entered into the memory 25. When all 2048 x-address positions have been filled the counter 32 resets to zero. Output from the analogue to digital converter 28 continues to be entered into the memory 25 overwriting the existing information.

The content of the memory 25 is shown pictorially in Figure 5, successive scans by the sensor 11 are entered into column C1, C2, C2046. Only a small number (256) of columns Ci are to be displayed on the cathode ray tube 48. To display on the cathode ray tube 48 part of the memory 25 is read by scanning a line at a time as follows. The read/write switch 45 is set to read by the line drive pulse, 8uppose that counters 37, 36, 39, are at zero- the y-address and x-address is then zero. The counter 36 cycles through 0-255 thus addressing 256 x-positions at y = 0.

The output of the memory 25 is displayed as a horizontal line on the cathode ray tube 48. After a line has been displayed the line drive pulse resets the counter 36 and indexes the counter 37. The y-address is now y = 1. At the end of the line drive pulse the counter 36 cycles through 0-255 and another line of information is written on the cathode ray tube

48. This continues until a whole frame of 128 lines (y = 1 to 128) has been written on the cathode ray tube 48.

A line of information is written on the cathode ray tube in 52 μsec with a flyback time of 12 μsec. During this flyback time new information can be entered into the memory 25 as the line drive pulse changes the switch 45 between read and write.

As described the information e,g. about the lorry 1, remains stationery in the memory 25. To effect a movement of the vehicle lorry 1 on the cathode ray tube 48 an indexing of the sections read is needed.

The counter 39 is incremented by each overflow pulse and its output is added 38 to that of the counter 36. Thus the 256 different columns read each cathode ray tube field time is gradually indexed along the memory 25. This gives the effect, on the cathode ray tube 48, of a vehicle moving across the screen at the speed of the vehicle 1 past the sensor head 6.

To stop a vehicle 1 moving across the cathode ray tube 48 the overflow pulse to the counter 39 is stopped on operation of the freeze switch 42. This ensures the same 256 x positions are read repetitively until the freeze switch 42 is released.

A fast forward pan is achieved by operation of the fast forward switch 41. This increases the counter 39 output rate.

Similarly a fast backwards pan is controlled via the fast backwards pan switch 44 applying pulses to decrease the counter 39 output. A slow backward pan is controlled by the switch 43 decreasing the counter 39 output.

This panning, backwards and forwards, allows an operator to study a particular vehicle 1, 2, for up to about 40 seconds. Larger memories allow longer study

One advantage of the invention is that background clutter is effectively eliminated. When nothing is moving past the sensor head 6 the sensor element 11 output is an unchanging vertical pattern of background. This appears on the cathode ray tube as horizontal parallel unvarying lines of different brightness. A moving vehicle contrast over background appears enhanced.

Figures 6 shows a circuit for further increasing contrast.

Output from the sensor head 6 is fed to both a comparator 51 and a 128 element delay 52. Output from the delay 52 is connected to the comparator 51. A selector 53 has one input from the sensor 6 and a control input from the comparator 51. If the sensor 6 output is unvarying from one scan to the next the comparator 51 output is zero and no information is sent by the selector 53 to the memory 25. When information from the sensor 6 changes then it is passed to the memory 25 as described above,

This Figure 6 circuit can also be used to control a recording, For some cases real-time observations of traffic is unnecessary.

In these cases a recording may be made of the sensor head output.

An audio cassette tape is adequate for this. The tape is later played back and results displayed on the cathode ray tube.

CLAIMS

1 An imaging system comprising a row of sensor elements which in operation is arranged substantially vertically, means for sequentially sampling the sensor element output, means for transmitting and receiving the sensor elements outputs, a memory array capable of storing signals representing successive samples of sensor element output, means for writing the sensor outputs into the memory, means for cyclically reading out a section of the memory, a display unit for observing the memory output, means for varying the section of memory read cyclically into the display: whereby vehicles moving past the sensors may be observed to move across the display at a speed dependent on the vehicle's speed or at a speed and direction controlled by an operator.

2. The system of claim 1 wherein the sensors are photo sensors.

3. The system of claim 1 wherein the sensors are infra red sensors.

4. The system of claim 1 wherein the sensors are microwave sensors.

5. The system of claim 1 and further including a delay and comparator for detecting the presence of moving vehicles.

6. The system of claim 1 constructed, arranged, and adapted to operate substantially as hereinbefore described with refence to the accompanying drawings.

Printed in the United Kingdom for
Her Majesty's Stationery Office, Dd 8818935, 1985, 4235.
Published at The Patent Office, 25 Southampton Buildings,
London, WC2A 1AY, from which copies may be obtained.